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Diagnostic accuracy of ultrasonography, computed tomography, cystoscopy and cytology to detect urinary tract malignancies in patients with asymptomatic hematuria

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Abstract: **PURPOSE:** To report the incidence of urinary tract malignancies (UTM) and to compare the diagnostic accuracy of cytology with cystoscopy, renal ultrasound (US) and computed tomography (CT) in patients with hematuria. **METHODS:** A retrospective analysis was conducted of patients who underwent cystoscopy, cytology, US and CT for hematuria between 2011 and 2017. Age, gender, BMI, smoking status, and results of further diagnostic interventions including transurethral resection of the bladder (TURB), ureterorenoscopy (URS), renal biopsy and imaging were extracted from medical charts. Logistic regression to identify risk factors for UTM was performed. Discriminatory accuracy of US, CT and cytology was assessed by 2×2 tables. **RESULTS:** Of 847 patients, 432 (51%) presented with non-visible hematuria (NVH) and 415 (49%) with visible hematuria (VH). Of all patients with NVH, seven (1.6%) had bladder cancer (BCA), three ($< 1\%$) had renal cell cancer (RCC) and no single patient had upper tract urothelial cancer (UTUC). Of the patients with VH, 62 (14.9%) were diagnosed with BCA, 7 (1.6%) with RCC and 4 ($< 1\%$) with UTUC. In multivariable analysis VH, higher age, smoking and lower BMI were associated with an increased risk for UTM. The specificity/negative predictive value of US for the detection of RCC or UTUC in patients with NVH and VH were 96%/100% and 95%/99%, respectively. **CONCLUSION:** Due to the low incidence of UTM, the necessity of further diagnostics should be questioned in patients with NVH. In contrast, patients with VH are at considerable risk for BCA, and cystoscopy and upper tract imaging is justified.

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Table 3 Comparison of discriminatory accuracy of US, CT and urine cytology to diagnose BCA, RCC and UTUC

Diagnostic test	Reference standard	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
All hematuria patients					
US	Histopathological confirmation of RCC or UTUC	0.57(0.29-0.82)	0.96 (0.94-1.00)	0.18 (0.08-0.32)	0.99 (0.99-1.00)
CT	Histopathological confirmation of RCC or UTUC	CT as reference	0.94 (0.92-0.96)	0.22 (0.13-0.34)	CT as reference
Cystoscopy	Histopathological confirmation of BCA	Cystoscopy as reference	0.96 (0.94-0.97)	0.68 (0.58-0.77)	Cystoscopy as reference
Cytology	Histopathological confirmation of BCA and/or UTUC	0.60 (0.44-0.75)	0.97 (0.96-0.98)	0.60 (0.44-0.75)	0.97 (0.96-0.98)
Cytology	Histopathological confirmation of BCA	0.64 (0.47-0.79)	0.97 (0.95-0.98)	0.58 (0.42-0.73)	0.98 (0.96-0.99)
Cytology	Histopathological confirmation of CIS only disease	0.50 (0.12-0.88)	1.00 (0.99-1.00)	0.75 (0.19-0.99)	0.99 (0.99-1.00)
Non visible hematuria patients					
US	Histopathological confirmation of RCC or UTUC	0.33 (0.01-0.91)	0.96 (0.94-0.98)	0.06 (0.00-0.27)	1.00 (0.98-1.00)
CT	Histopathological confirmation of RCC or UTUC	CT as reference	0.95 (0.92-0.97)	0.12 (0.03-0.31)	CT as reference
Cystoscopy	Histopathological confirmation of BCA	Cystoscopy as reference	0.98 (0.96-0.99)	0.47 (0.21-0.73)	Cystoscopy as reference
Cytology	Histopathological confirmation of BCA	0.40 (0.05-0.85)	0.99 (0.97-1.00)	0.29 (0.04-0.71)	0.99 (0.97-1.00)
Cytology	Histopathological confirmation of CIS only disease in the bladder	0.00 (0.00-0.52)	1.00 (0.98-1.00)	0.00 (0.00-0.97)	0.99 (0.97-1.00)
Visible hematuria patients					
US	Histopathological confirmation of RCC or UTUC	0.64 (0.31-0.89)	0.95 (0.92-0.97)	0.26 (0.11-0.46)	0.99 (0.97-1.00)
CT	Histopathological confirmation of RCC or UTUC	CT as reference	0.94 (0.91-0.96)	0.28 (0.15-0.45)	CT as reference
Cystoscopy	Histopathological confirmation of BCA	Cystoscopy as reference	0.93 (0.90-0.95)	0.72 (0.61-0.81)	Cystoscopy as reference
Cytology	Histopathological confirmation of BCA and/or UTUC	0.63 (0.46-0.78)	0.95 (0.92-0.98)	0.67 (0.49-0.81)	0.95 (0.91-0.97)
Cytology	Histopathological confirmation of BCA	0.68 (0.49-0.83)	0.95 (0.92-0.97)	0.64 (0.46-0.79)	0.96 (0.93-0.98)
Cytology	Histopathological confirmation of UTUC	0.25 (0.01-0.81)	0.88 (0.84-0.92)	0.03 (0.00-0.15)	0.99 (0.97-1.00)
Cytology	Histopathological confirmation of CIS only disease in the bladder	1.00 (0.29-1.00)	0.95 (0.92-0.97)	0.19 (0.04-0.46)	1.00 (0.99-1.00)

Abbreviations BCA: bladder cancer, CI: confidence interval; CT: computerized tomography; NPV: negative predictive value; PPV: positive predictive value; RCC: renal cell carcinoma US: ultrasonography, UTUC: upper tract urothelial carcinoma